Interview with Benjamin Erable (24/03/20)

WHO ARE WE INTERVIEWING? (job, studies…)

Responsible of research at CNRS, specialist in electroactive biofilms.

CONTEXT (Why did we do this interview?)

Our system involves the production of dihydrogen via electrolysis which feeds our acetogens, we called Benjamin Erable so he could enlighten us on the implementation of such a system and the possible obstacles we need to consider.

INTERVIEW (summary of the interview)

M. Erable started by explaining that electrosynthesis is a system made of two steps. First, there is a synthesis of dihydrogen by the electrolysis of water. Followed by the conversion of this dihydrogen and CO2 into biomass by the acetogens. Two methods can be used in order to get this reaction. For the in-situ method, the electrodes are inside the reactor where the acetogens are found. But, if the electrolysis is performed outside the bioreactor, and the dihydrogen flow is redirected towards the bioreactor, then we can reach higher energy yields than with the in-situ method.

We choose to synthetize dihydrogen outside the bioreactor with a commercial EMP. This implies that the acetogens will grow in suspension. In this case we need to use a membrane with a cutoff threshold that allows us to compartmentalize yeast and acetates but still letting the metabolites go through.

But we have other problems to consider for the dihydrogen dissolution: we need to prevent acetogens from perceiving the oxygen.

In order to have a better dihydrogen dissolution, M. Erable suggested using a hollow fiber membranes to redirect the dihydrogen flow. These membranes allow us to have a progressive dissolution of dihydrogen and we could have an acetogen biofilm formation around the fibers. He advises us to contact a TBI team who work on gas-liquid contactors with hollow fiber membranes.

Then, it's more desirable to use an anaerobic acetogen in order to produce acetate and to not compete with yeast for the dioxygen. However, the acetogens need to be able to have a tolerance for dioxygen because both species will grow in the same bioreactor. Using the hollow fiber membrane and the electrolysis ex-situ will avoid that acetogens perceive dioxygen because we will be able to control the dioxygen flow and its dissolution. And to make sure that our acetogens won't be intoxicated because of the presence of dioxygen, we will work in conditions where dioxygen is the limiting parameter of the system.

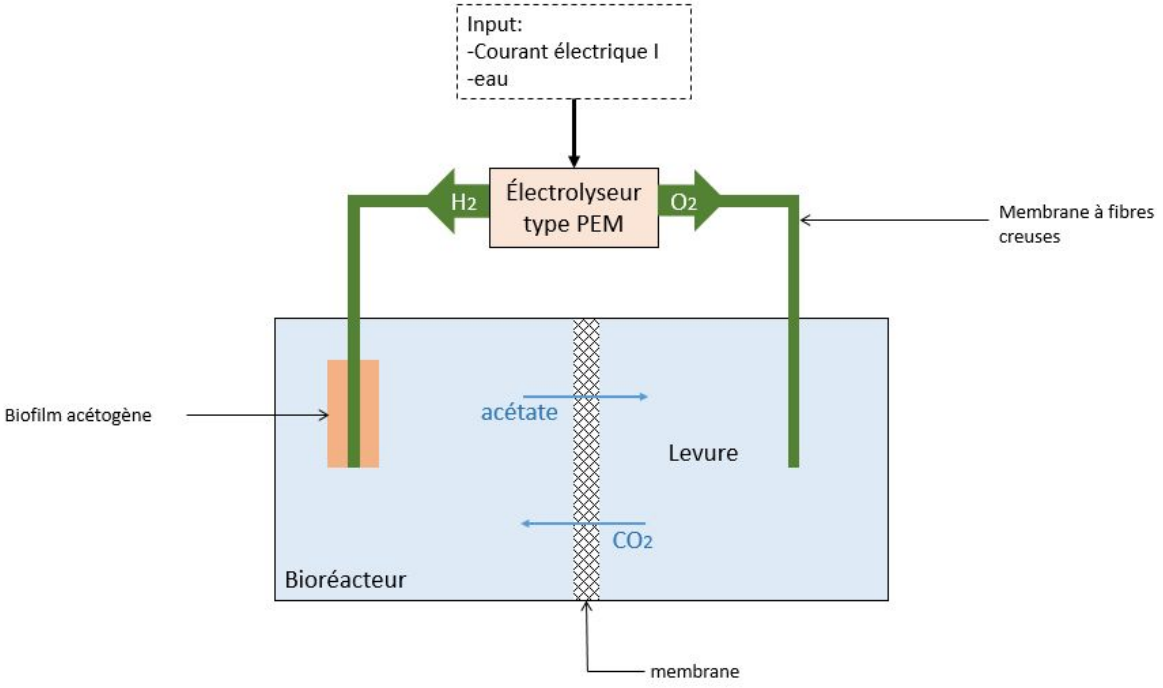

Diagram of the system made with M. Erable

From a global system point of view, Benjamin Erable has pointed out certain aspects which we must think about:

- We need to have little maintenance of the culture and simple set up of the performance indicators so that someone who isn't a biochemist or microbiologist can still take care of it.
- Because dioxygen will be a limiting factor, we could integrate into the system a regulation loop acting on the electrolyzer in order to regulate the flow of dihydrogen and the flow of dioxygen.
- To start up the system, we should use lyophilized strains rather than cryopreserved ones because they will be easier to handle. Benjamin Erable takes the example of *Capri Sun* drinks, the culture would be in a lyophilized bag, and it would be enough to rehydrate the culture and switch on the system (by current induction). And finally, to stick a straw in the yeast compartment to consume them.
- We should ask CNES, or an astronaut, if the use of urine in space is possible, and how is urine treated. And what other waste could we use?

We talked about the induction system that we want to use to produce vitamins. He advised against photoinduction because the culture medium will probably be to opaque… But still with the idea of a flexible bag, he suggested placing a vial with the inductor and then break the vial when we want to start the production of vitamins.

We talked about the dangers of dihydrogen which could scare the general public. Dihydrogen can be explosive when it's stored or used in high pressures and mixed with dioxygen. Otherwise it has no risk, and many industries use hydrogen batteries.

Finally, in order to move forward in our project on the electrosynthesis part, we have to go from the final production objective and go back up to get the hydrogen flow that needs to be supplied. We must therefore have an idea of the conversion yields of acetate to vitamin, of dihydrogen to acetate and of the dissolution of dihydrogen in a liquid medium.